

# Review of the genus *Lunidia* Hemp (Orthoptera: Phaneropteridae) and the description of a new species from the Uluguru Mountains of Tanzania, East Africa

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## Abstract

The genus *Lunidia* Hemp is reviewed and more data on its distribution and habitat provided. A new species, *Lunidia bicercata* sp. n., from the Uluguru Mountains, is newly described. A key to males of *Lunidia* is provided.

## Key words

Eastern Arc Mountains, Ensifera, speciation, taxonomy, taxonomic key

## Introduction

The Uluguru Mountains in Tanzania belong to a series of mountain ranges, the so-called Eastern Arc Mountains. Stretching from southern Tanzania to southern Kenya, these mountain blocks are geologically old, thought to be more than 30 million years old (Rodgers and Homewood 1982). Due to their advanced geological age and their climatic conditions, which have supported forest cover for probably several million years, these mountains are hotspots of biodiversity and endemism. Various Orthoptera genera from the Eastern Arc ranges have been shown to consist of an array of morphologically similar endemic species. This observed biodiversity and endemism is due to the rather unstable climatic conditions of the region. An increasing aridification of Africa about 8 million years ago led to a decline of forest cover and caused savanna vegetation to spread over large parts of Africa. However, humid periods (Trauth et al. 2005) lead to an increase of forest cover again connecting isolated forest areas, e.g. on the Eastern Arc ranges. This enabled forest-dependent forest taxa to spread. After isolation and a retreat of forest to higher elevations due to an ongoing aridification, especially flightless taxa adapted to a mountainous forest climate or went extinct. That these processes led to the biogeographical pattern we see today for flightless Orthoptera was shown e.g. for species of the tiny lentulids *Rhainopomma* and *Altiusambilla* (Lentulidae; Schultz et al. 2007, Hemp et al. 2007), the coptacridine genus *Parepistaurus* (Hemp et al. 2015) and members of the Karniellina (Conocephalinae) in the genera *Fulvosciartes*, *Chortosciartes*, and *Melanosciartes* (Hemp et al. 2010a, c, 2012). This

suggests that climatic fluctuations of the past 1–2 million years were the drivers of the high biodiversity in the area and that most orthopteran species are the product of a young radiation.

The genus *Lunidia* Hemp was erected on *L. viridis* from Mt Kilimanjaro in Tanzania. *L. viridis* is a forest dependent species common in the submontane and lower montane zone. Hemp et al. (2010b) provided data on the altitudinal distribution of *L. viridis* on Mt Kilimanjaro and characterized its ecological niche. Further data on its karyotype were presented, showing that *Lunidia* exhibits a karyotype typical for most Tettigoniidae. *L. viridis* has an unusually complex and variable song, which was described from field and laboratory recordings. Hemp (2017) described a second species of *Lunidia*, *L. acuticercata*, from lowland and coastal forests found in the spirit collection of the Zoological Museum Copenhagen, Denmark. With the detection of this second species, generic characters had to be revised for the genus *Lunidia*. The projection running from the face to the fastigium verticis was more acute in *L. acuticercata* and not conus-like and blunt as given for *L. viridis* and the generic description for *Lunidia*. A third species of *Lunidia* has now been detected in submontane forest of the Uluguru Mountains. I describe this third species of the genus *Lunidia* and provide more distribution and habitat data on *L. viridis*.

## Material and methods

**Sampling.**— Bushcrickets (a.k.a. katydids; Orthoptera: Tettigoniidea) were collected by searching, by light trapping or acoustically. Submontane forest above Morningside in the Uluguru Mountains was surveyed in February, March, April, June, August and November 2016 and February 2017.

**Identification.**— The Orthoptera specimens were identified either with available literature or with the help of the Orthoptera Species File (Cigliano et al. 2017), a web-based catalogue of the order Orthoptera. The material was then checked for verification with the collections of the Natural History Museum London, UK, the Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Germany (MfN), Naturhistorisches Museum

Wien, Austria, and the entomological collection of the Zoologisk Museum, Copenhagen.

*Electronic content and hyperlinks.*— This manuscript includes ‘hyperlinks’ to the Orthoptera Species File (OSF) online (<http://orthoptera.speciesfile.org>) (Cigliano et al. 2017) following procedures described in Cigliano and Eades (2010). Taxon LSIDs provided by OSF are also included. Life Science Identifiers (LSIDs) are globally unique identifiers used for biodiversity data and provide a way to track and find metadata of taxa on the internet.

*Measurements.*— Measurements of body length include male genitalia but not the ovipositor of the female.

*Depositories.*— MfN: Museum für Naturkunde, Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Berlin.

## Results

### Redescription of the genus *Lunidia*

Fastigium slightly narrower than first antennal segment; forming a finger-like projection ending slightly before scapus when looked at from above. This projection either blunt and conus-like (*L. viridis*, *L. bicercata* sp. n.) or more acute (*L. acuticercata*). Met from below by a conus-like projection of the face, leaving gap between both tips. Eyes circular, prominent. *Thorax*: Smooth surface, without lateral or median carinae. Fore coxae with spine. Fore and mid femora unarmed. Fore tibiae with open tympanum on each side.

*Wings*: Wings fully developed, hind wings protruding some mm beyond fore wings. Veins Sc and R either contiguous or separating at their distal ends.

#### *Lunidia bicercata* sp. n.

<http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile>

org:TaxonName:499483

<http://zoobank.org/C8A0E872-4647-416C-AF1A-3C9E9C88F8D4>

Figs 1–5

*Holotype.*— Male, Tanzania, Uluguru Mountains, submontane forest above Morningside, February 2016. Depository MfN. Paratypes: 1 female, same data as holotype. Depository MfN.

Further paratype material: 4 females, same data as holotype but November 2016 and February 2017. Collection C. Hemp.

*Description.*— **Male.** *General habitus and color*: Uniformly green with dark marking at base of left tegmen (Figs 1A, 2D), a few dark spots on tegmina and the tympana marked brownish. Venter of abdomen white (Fig. 1A). *Head and antennae*: Antenna thin, slightly longer than flexed tegmina. Fastigium verticis elongated, surface smooth. Conus-like projection of the face running to fastigium verticis acute and thin. *Thorax*: Fore coxae with slender, slightly curved spine. Fore and mid femora unarmed. Hind femora at posterior narrow part ventrally with double row of few spines. *Wings*: Tegmina oval, rounded at tip; hind wings hyaline except area protruding beyond tegmina, which have the same color as the tegmina. Sc and R contiguous. Stridulatory file contiguous (Fig. 2E), mirror of right tegmen as in Fig. 2F. *Abdomen*: Last abdominal tergite broad with median depression at posterior margin (Fig. 2A, B). Cerci stout with bidentate tips (Fig. 2B). Subgenital plate

elongated, surpassing cerci, v-shaped incised at posterior margin (Fig. 3C).

**Female.** Body size and color pattern as male but without brown patch on left tegmen but with two dark patches at bases of tegmina (Fig. 1B). Wing venation and spination of the legs as in male. Ovipositor with sclerotized margins along the serration of the valves (Fig. 2C). Subgenital plate triangular with indentation at tip (Fig. 4B).

Measurements, male (mm) (n=1): Total length of body 22.5; Length of pronotum 5.2; Length of hind femur 20.2; Length of elytra 25.

Measurements, females (mm) (n=4): Total length of body 22.0–23.0; Length of pronotum 5.4–5.6; Length of hind femur 21.0–21.7; Length of elytra 25–26.5; Length of ovipositor 6.6–7.0.

*Diagnosis.*— A typical *Lunidia* species from its size and habitus. Males of the three species can easily be distinguished when comparing the subgenital plate (Fig. 3). *L. viridis* has an elongated and narrow subgenital plate forming two finger-like processes at its posterior end (Fig. 3A). *L. acuticercata* also has an elongated subgenital plate which is however deeply split into two rounded lobes (Fig. 3B). *L. bicercata* sp. n. has a shorter and broader subgenital plate, v-shaped incised at its posterior end (Fig. 3C). Further, the cerci of all three species differ considerably in their morphology: long and stout with a ridge at its tips in *L. viridis* (Fig. 3A), stout with inflated base, acute tips embracing the subgenital plate in *L. acuticercata* (Fig. 3B) and stout and curved with bi-dentate tips in *L. bicercata* sp. n. (Fig. 3C).

Female *Lunidia* species may be distinguished by comparing the subgenital plates (Fig. 4). *L. viridis* has a broad wing-like subgenital plate with a posterior broad indentation (Fig. 4A) while *L. acuticercata* has a stout subgenital plate forming two broad evenly rounded lobes at the posterior end (Fig. 4C). *L. bicercata* sp. n. has an almost tri-angular subgenital plate with a short indentation at its posterior tip (Fig. 4B). However, *L. viridis* and *L. bicercata* sp. n. females are morphologically very similar. *L. viridis* only occurs in northern Tanzania while *L. bicercata* sp. n. seems to be restricted to the Uluguru Mountains. *L. acuticercata* is a species of lowland wet forest and probably occurs along the Tanzania coast in suitable habitats and further inland in lowland forest.

*Habitat.*— Submontane forest.

*Biology.*— Single oval and black eggs are deposited between the tissue layers of leaves. Adults and nymphs were only collected in January and February suggesting a similar cycle as for *L. viridis* (see below).

*Etymology.*— Named with reference to the bidentate male cerci.

*Distribution.*— At present only known from the Uluguru Mountains of central Tanzania.

#### *Lunidia viridis* Hemp, 2010

<http://lsid.speciesfile.org/urn:lsid:Orthoptera.speciesfile>

org:TaxonName:11252

*Remarks.*— Since its description, further populations of this species were found in northern Tanzania. Thus *L. viridis* is a common inhabitant of montane forests on Mt Meru at around 1700 m. Adults were exclusively found in November and December (2013,





Fig. 1. *Lunidia bicercata* sp. n., Uluguru Mountains. A. Male; B. Female.

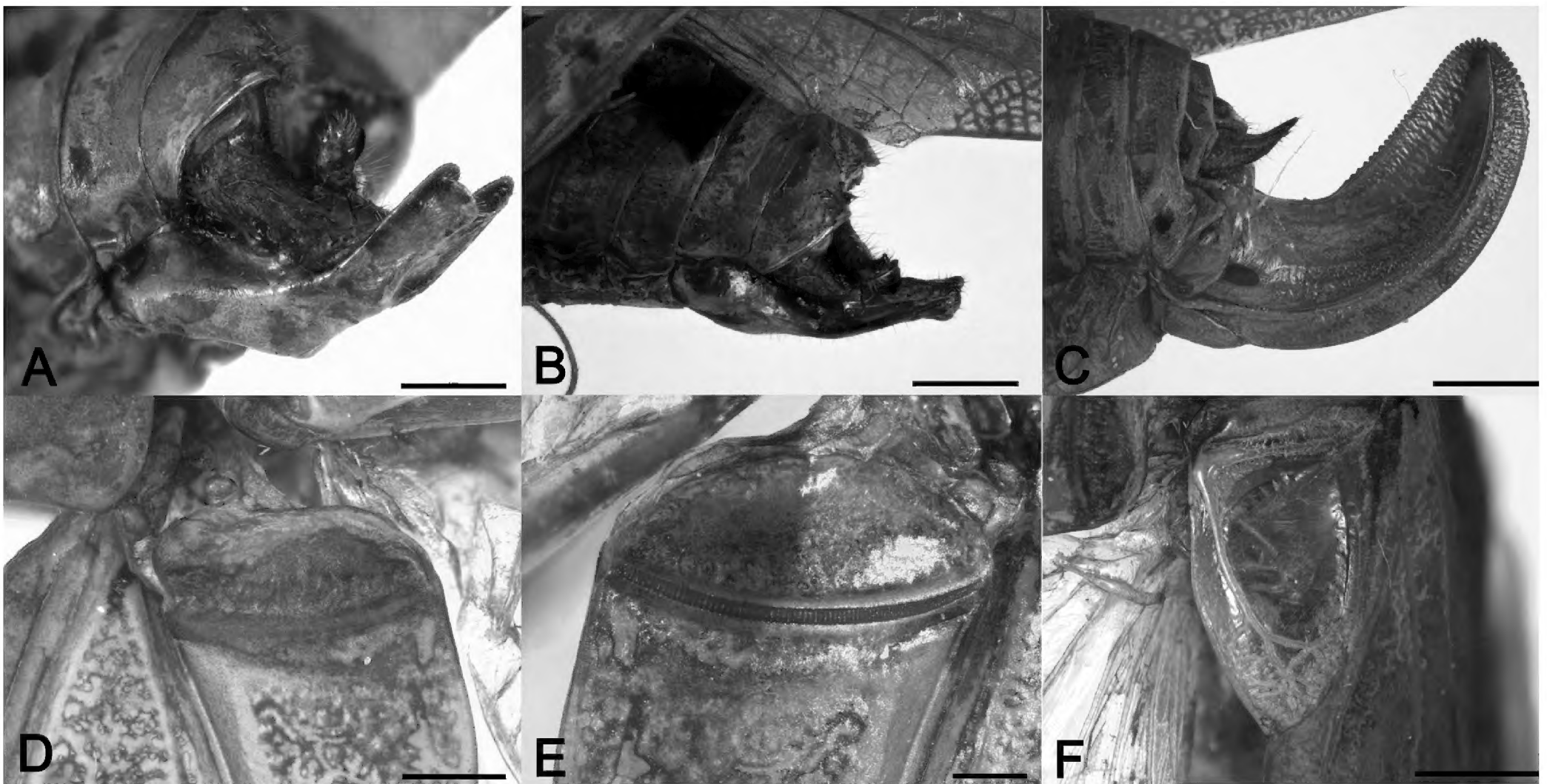


Fig. 2. Morphological details of *Lunidia bicercata* sp. n. A, B. Semilateral view on male abdominal apex; C. Ovipositor of female; D. Stridulatory area on left tegmen of male; E. Male stridulatory file, inner side left tegmen; F. Mirror on right tegmen of male. A, C, D, F. Scale bars: A, B. 1 mm D, E. 0.5 mm C, F. 2 mm.

2014 and 2015). It also occurs in montane forest on the North Pare Mountains at elevations of 1750-1800 m at the lower border of the forests on Mt Kindoroko. Also, here it was only collected in November and December. On the South Pare Mountains, a small population was detected on the isolated mountains Umari at the western end of the South Pare Mountains and here also at elevations of 1700-1800 m in December 2017. Lutindi forest at the southern end of the West Usambara Mountains also harbors a population of *L. viridis* but here in submontane elevations at about 1250 m. The song could not yet be recorded for this population and further studies have to be conducted to verify species status, although morphologically specimens caught in this area agree with specimens from Mt Kilimanjaro. Also Mazumbai Forest

Reserve, West Usambara Mountains, harbors *L. viridis* in montane elevations at about 1600-1700 m, but the male cerci are stouter suggesting that this population is isolated. The song recorded is typical for *L. viridis* though. Thus *L. viridis* occurs in montane forests throughout northern Tanzania (Fig. 5).

**Biology.**— In addition to feeding on leaves, *L. viridis* also feeds on dead insects, also attacking individuals of its own species when caged together. *L. viridis* hatches with the onset of the short rains from October onwards. Adults are usually found from November/December to March/April. This same pattern was seen in all known populations of northern Tanzania. Thus *L. viridis* produces only one generation per year.

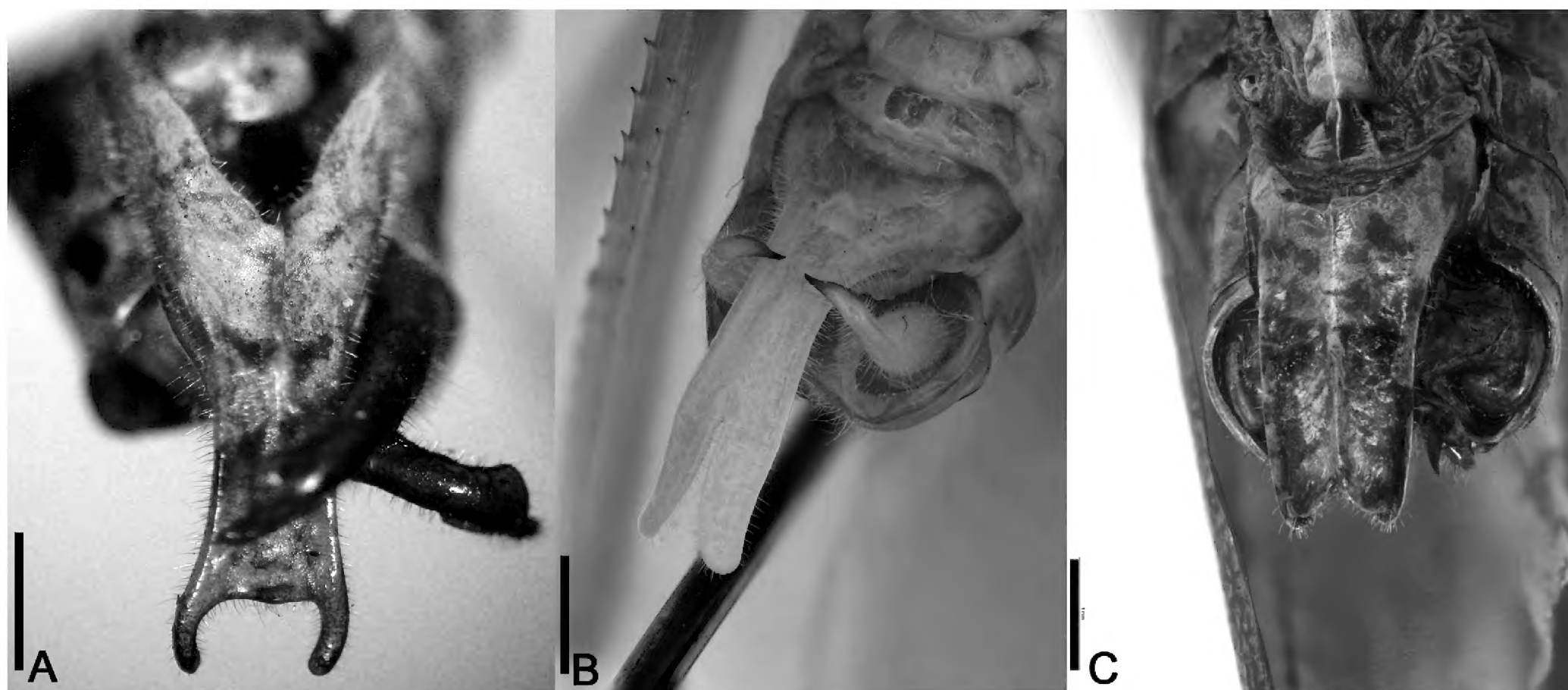


Fig. 3. Subgenital plates of male *Lunidia* species. A. *L. viridis*; B. *L. acutercata*; C. *L. bicercata* sp. n. Scale bars: 1 mm.

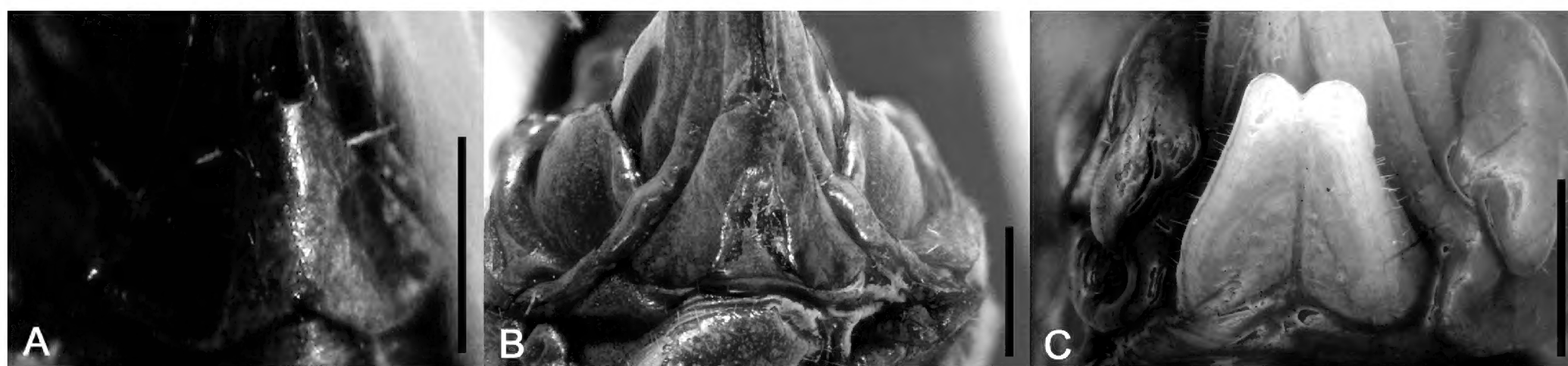


Fig. 4. Subgenital plates of female *Lunidia* species. A. *L. viridis*; B. *L. bicercata* sp. n.; C. *L. acutercata*. Scale bars: 1 mm.

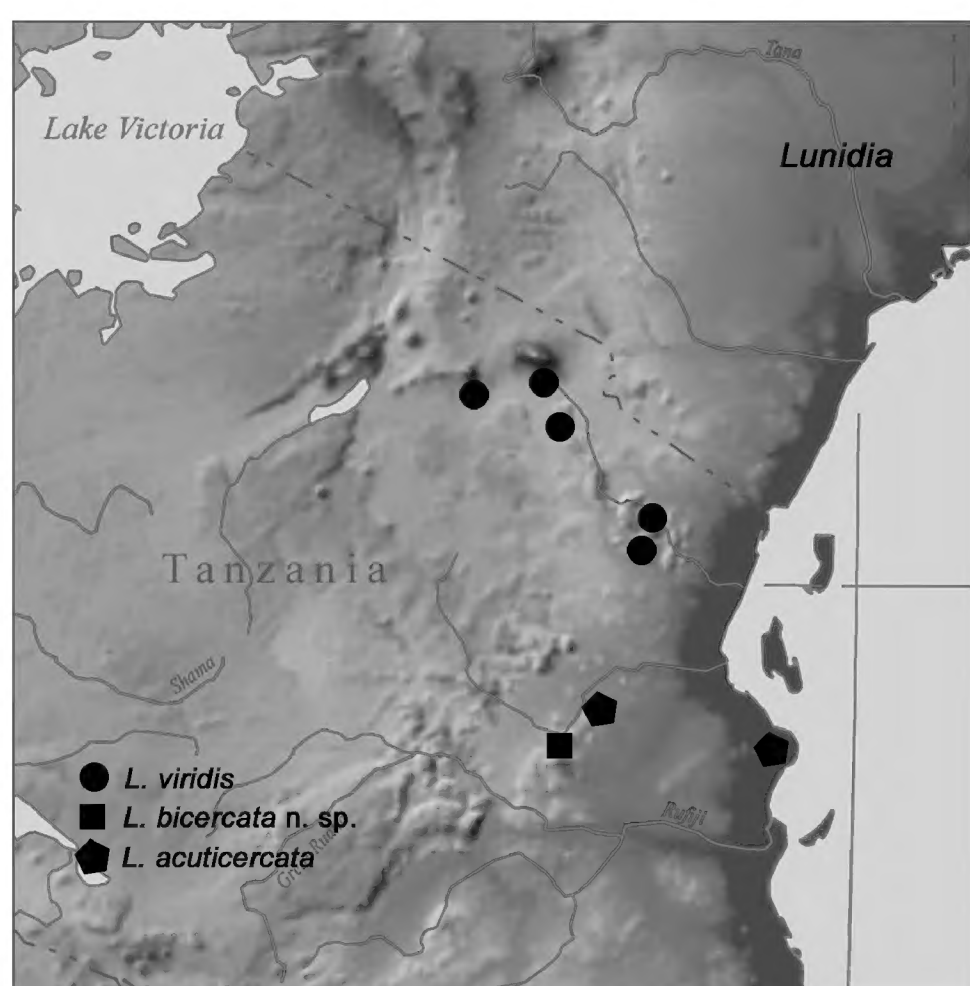


Fig. 5. Distribution of *Lunidia* species in East Africa.

#### Key to the species of *Lunidia* (males)

- 1 Subgenital plate deeply bilobed. Cerci stretched downwards embracing subgenital plate. Coastal Tanzania and Morogoro District.....  
..... *L. acutercata* Hemp
- Subgenital plate not bilobed, cerci not embracing subgenital plate... 2
- 2 Subgenital plate broadly u-shaped incised with lateral finger-like processes. Cerci spoon-like expanded at tips. Northern Tanzania.....  
..... *L. viridis* Hemp
- Subgenital plate with median incision thus forming two shallow broad lobes at posterior end. Cerci with subapical dent. Tanzania, Uluguru Mountains.....*L. bicercata* sp. n.

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bling me to visit the Natural History Museum London, U.K., the Naturkunde Museum of Vienna, Austria and the collection of the Zoological Museum of Copenhagen, Denmark.

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